We Claim:

1. A hydraulic propulsion system, comprising:

a fluid reservoir for storing a supply of hydraulic fluid;

pump means having a pump inlet connected to said reservoir and a pump outlet;

means for driving said pump means for delivering pressurized fluid at said pump outlet;

a hydraulic motor having first and second motor fluid inlet/outlet ports;

an accumulator for storing hydraulic fluid under pressure and having an accumulator port for admitting fluid into and discharging fluid from said accumulator;

a device for maintaining a selectable pressure ratio between said accumulator and one of said motor ports, said device having a first port connected to said accumulator port, a second port connected to said fluid reservoir and a third port connected to a fluid flow control mechanism, said device being responsive to a deviation in the ratio of the pressures at said first and second ports from a predetermined pressure ratio by adding fluid to or removing fluid from said hydraulic system so as to restore said ratio to said predetermined pressure ratio; and

a fluid flow control mechanism having:

an first control port connected to said pump and to said third port of said device;

a second control port connected to one of said motor fluid inlet/outlet ports;

a third port connected to the other of said motor fluid inlet/outlet ports; and

a control valve responsive to operator inputs for selectively connecting:

said pump outlet to one of said motor fluid inlet/outlet ports for driving said motor;

said device third port and said pump outlet to one of said motor fluid inlet/outlet ports for driving said motor;

one of said motor fluid inlet/outlet ports to said device third port for supplying pressurized fluid to said device for charging said accumulator.

2. A propulsion system as defined in claim 1, further including a bidirectional control valve having a first input port connected to the output of said pump means and a second port connected to said device third port.

3. A propulsion system as defined in claim 1, further including a bidirectional control valve having a first input port connected to the output of said device first port and a second port connected to said accumulator port.

4. A propulsion system as defined in claim 1, said motor having an output shaft for driving connection to a wheel, further including clutch means for selectively connecting and disconnecting said motor from said wheel.

5. A hydraulic propulsion system, as defined in claim 1, said motor being a reversible, constant displacement vane type motor.

6. A hydraulic propulsion system, as defined in claim 5, said motor having

a housing;

a cam ring in said housing;

a shaft mounted in said housing for rotation therein and for driving connection to a ground engaging wheel;

a torque tube concentrically mounted on and freely rotatable with respect to said shaft;

a radial vane rotor secured to said torque tube for rotatably said tube;

a bidirectional clutch releasably connecting said torque tube and said shaft, said clutch being automatically engageable for driving the wheel and being manually engageable for effecting regenerative braking.

7. A hydraulic propulsion system for a human propelled vehicle having at least two ground-engaging wheels and a pair of foot operated treadles, said system comprising:

a fluid reservoir for storing a supply of hydraulic fluid;

a variable stroke piston pump associated with each said treadles, each said pump having an inlet connected to said reservoir and a pump outlet;

at least one reversible, constant displacement vane type hydraulic motor drivingly connected to one of said wheels, each said motor having a fluid inlet and a fluid outlet, an output shaft for driving connection to said wheel, and a clutch for selectively engaging and disengaging said motor from its associated wheel;

an accumulator for storing hydraulic fluid under pressure and having an accumulator port for admitting fluid into and discharging fluid from said accumulator;

a device for maintaining an operator selectable pressure ratio between said accumulator and motor fluid inlet, said device having a first port for connection to said accumulator, a second port for connection to said fluid reservoir and a third port connected to a fluid flow control mechanism; said device being responsive to a deviation in the ratio of the pressures at said first and second ports from a predetermined pressure ratio by adding fluid to or removing fluid from said hydraulic system so as to restore said ratio to said predetermined pressure ratio; and

a fluid flow control mechanism having:

a valve housing having an input port connected to the output of each said

pumps and to said third port of said device;

a motor port connected to each said at least one hydraulic motor;

a bidirectional control valve having a first input port connected to the output of said pump means and a second port connected to said device third port;

said control mechanism being responsive to operator inputs for selectively connecting said pump outlet to said motor fluid inlet, or for selectively connecting said device third port and said pump outlet to said motor fluid inlet or for connecting said motor outlet to said device third port;

8. A hydraulic propulsion system, as defined in claim 7, said motor having

a housing;

a cam ring in said housing;

a shaft mounted in said housing for rotation therein and for driving connection to a ground engaging wheel;

a torque tube concentrically mounted on and freely rotatable with respect to said shaft;

a radial vane rotor secured to said torque tube for rotatably said tube;

a bidirectional clutch releasably connecting said torque tube and said shaft, said clutch being automatically engageable for driving the wheel and being manually engageable for effecting regenerative braking.

9. A system as defined in claim 1 comprising:

a plurality of fluid cells arranged in sequence for movement along a predetermined path having first, second and third zones, each cell having a volume which varies depending on the position of said cell along the path;

said device having a first port for communicating with said hydraulic system, a second port for communicating with a pressurized fluid reservoir; and a third port for communicating with a source of fluid, each said port being arranged to communicate with at least one of said cells along said path, and at least two of said ports being exposed to fluid at different pressures, cells disposed in said first zone communicating with said first port, cells disposed in said second zone communicating with said second port, and cells disposed in said third zone communicating with said third port;

said device being responsive to a deviation in the ratio of the pressures at said first and second ports from a predetermined pressure ratio by moving said sequence of cells in one direction or the other along said path to cause said cells to deliver fluid to or remove fluid from said hydraulic system so as to tend to restore said ratio to said predetermined pressure ratio.

10. A system as defined in claim 9, at least one of said ports communicating with a cell which is in the process of changing size.

11. A system as defined in claim 10 said path being an endless path, and each said cells having a fluid passage for communicating with said second and third ports when disposed in said second and third zones, respectively.

12. A system as defined in claim 11, said device further including means for adjusting the length of said second and third zones along said path while maintaining the sum of the lengths of said second and third zones constant.

13. A system as defined in claim 12, said device being operable to maintain a selected pressure ratio between said
system and said pressurized fluid reservoir, said device further including:

a housing having said first, second and third ports and an inner endless cam surface;

a rotor mounted in said housing for rotation therein in opposed relation to said cam surface, said rotor having inner and outer surfaces, said outer surface and said cam surface defining at least two diametrically opposed chambers in said housing, a plurality of equally, angularly spaced vanes extending radially outwardly from said outer surface of said rotor for engagement with said cam surface and defining a plurality of fluid cells arranged in sequence for movement along an endless path through said at least two chambers; said rotor having a fluid passage communicating each said cell with said inner surface;

means mounted in said inner surface of said rotor for communicating said second port with fluid passages of associated cells disposed in said second zone and for communicating said third port with fluid passages of associated cells disposed in said third zone; and

means for selectively adjusting the relative size of said second and third zones.

14. A system as defined in claim 13, each said chamber progressively increasing in size from a minimum at each end thereof to a maximum intermediate said ends so as to cause the volume of each said fluid cell to vary as said cell traverses said chamber.

15. A system as defined in claim 14, said means for communicating including:

a porting member secured to said housing and mounted within said inner surface of said rotor; and

a control member associated with said porting member for adjusting said second and third zones.

16. A system as defined in claim 15, said porting member having a central axis and an opening associated with each said chamber, each said opening communicating with inner ends of fluid passages of cells disposed in said second and third zones;

said control member being mounted in said porting member for pivotal movement about said central axis of said porting member and having a vane associated with each said opening for dividing its associated opening into a pair of circumferentially adjustable openings, one of said adjustable openings communicating with said second port and the other of said adjustable openings communicating with said third port.

17. A system as defined in claim 15, said porting member having a central axis, an opening associated with each said chamber, each said opening communicating with inner ends of fluid passages of cells disposed in said second and third zones;

said control member being mounted in said porting member for pivotal movement about said central axis of said porting member and having a control passage connecting opposed openings in said porting member for communicating cells in opposed chambers, said porting member and said control member defining an adjustable space on each said of control passage, one of said adjustable spaces communicating with said second port and the other of said adjustable spaces communicating with said third port, said spaces being adjustable by pivotal movement of said control member between extremes in which one of said spaces is fully closed and the other of said spaces is fully open.

18. A system as defined in claim 1, said device comprising:

a housing having:

an inner endless cam surface,

a first port for communicating with said hydraulic system,

a second port for communicating with a pressurized fluid reservoir; and

a third port for communicating with a source of fluid;

a rotor mounted in said housing for rotation therein in opposed relation to said cam surface, said rotor having:

inner and outer surfaces, said outer surface and said cam surface defining at least two diametrically opposed chambers in said housing, each said chamber having having first, second and third angularly arranged zones;

a plurality of equally, angularly spaced vanes extending radially outwardly from said outer surface of said rotor for engagement with said cam surface and defining a plurality of fluid cells arranged in sequence for movement along an endless path through said at least two chambers, each cell having a volume which varies depending on the position of said cell in said chambers;

a fluid passage associated with each said cell for communicating each said cell with said inner surface of said rotor;

each said port being arranged to communicate with at least one of said cells along said path, at least two of said ports being exposed to fluid at different pressures, cells disposed in said first zone communicating with said first port, cells disposed in said second zone communicating with said second port, and cells disposed in said third

zone communicating with said third port;

means mounted in said inner surface of said rotor for communicating said second port with fluid passages of associated cells disposed in said second zone and for communicating said third port with fluid passages of associated cells disposed in said third zone; and

means for selectively adjusting the relative size of said second and third zones to set a desired pressure ratio between the pressures at said first and second ports;

said device being responsive to a deviation in the ratio of the pressures at said first and second ports from said desired pressure ratio by rotating said rotor in a direction to cause said cells to deliver fluid to or remove fluid from said hydraulic system until said ratio reaches said desired pressure ratio.

19. A system as defined in claim 18, said rotor having concentric, inner and outer cylindrical surfaces, said inner surface being mounted on said outer surface of said porting member, each said rotor port having an inner end communicating with said outer surface of said porting ring.

20. A system as defined in claim 19, said ports being arranged such that during each revolution of said rotor, said movable cells communicate with said third port through a predetermined angular displacement of said rotor, said radial rotor ports communicate with said opening on one side of said control vane through a second angular displacement of said rotor and said radial rotor ports communicate with said opening on the other side of said control vane through a third angular displacement of said rotor; said control vanes being operable to adjust said second and third angular displacements.

21. A fluid management device for managing fluid in a hydraulic system, comprising:

a plurality of fluid cells arranged in sequence for movement along a predetermined path having first, second and third zones, each cell having a volume which varies depending on the position of said cell along the path;

said device having a first port for communicating with said hydraulic system, a second port for communicating with a pressurized fluid reservoir; and a third port for communicating with a source of fluid, each said port being arranged to communicate with at least one of said cells along said path, and at least two of said ports being exposed to fluid at different pressures, cells disposed in said first zone communicating with said first port, cells disposed in said second zone communicating with said second port, and cells disposed in said third zone communicating with said third port;

said device being responsive to a deviation in the ratio of the pressures at said first and second ports from a predetermined pressure ratio by moving said sequence of cells in one direction or the other along said path to cause said cells to deliver fluid to or remove fluid from said hydraulic system so as to tend to restore said ratio to said predetermined pressure ratio.

22. A fluid management device as defined in claim 21, at least one of said ports communicating with a cell which is in the process of changing size.

23. A fluid management system as defined in claim 22, said path being an endless path, and each said cells having a fluid passage for communicating with said second and third ports when disposed in said second and third zones, respectively.

24. A device as defined in claim 21, said device further including means for adjusting the length of said second and
third zones along said path while maintaining the sum of the lengths of said second and third zones constant.

25. A device as defined in claim 21, said device being operable to maintain a selected pressure ratio between said system and said pressurized fluid reservoir, said device further including:

a housing having said first, second and third ports and an inner endless cam surface;

a rotor mounted in said housing for rotation therein in opposed relation to said cam surface, said rotor having inner and outer surfaces, said outer surface and said cam surface defining at least two diametrically opposed chambers in said housing, a plurality of equally, angularly spaced vanes extending radially outwardly from said outer surface of said rotor for engagement with said cam surface and defining a plurality of fluid cells arranged in sequence for movement along an endless path through said at least two chambers; said rotor having a fluid passage communicating each said cell with said inner surface;

means mounted in said inner surface of said rotor for communicating said second port with fluid passages of associated cells disposed in said second zone and for communicating said third port with fluid passages of associated cells disposed in said third zone; and

means for selectively adjusting the relative size of said second and third zones.

26. A device as defined in claim 25, each said chamber progressively increasing in size from a minimum at each end thereof to a maximum intermediate said ends so as to cause the volume of each said fluid cell to vary as said cell traverses said chamber.

27. A device, as defined in claim 26, said means for communicating including:

a porting member secured to said housing and mounted within said inner surface of said rotor; and

a control member associated with said porting member for adjusting said second and third zones.

28. A device as defined in claim 27, said porting member having a central axis and an opening associated with each said chamber, each said opening communicating with inner ends of fluid passages of cells disposed in said second and third zones;

said control member being mounted in said porting member for pivotal movement about said central axis of said porting member and having a vane associated with each said opening for dividing its associated opening into a pair of circumferentially adjustable openings, one of said adjustable openings communicating with said second port and the other of said adjustable openings communicating with said third port.

29. A device as defined in claim 27, said porting member having a central axis, an opening associated with each said chamber, each said opening communicating with inner ends of fluid passages of cells disposed in said second and third zones;

said control member being mounted in said porting member for pivotal movement about said central axis of said porting member and having a control passage connecting opposed openings in said porting member for communicating cells in opposed chambers, said porting member and said control member defining an adjustable space on each said of control passage, one of said adjustable spaces communicating with said second port and the other of said adjustable spaces communicating with said third port, said spaces being adjustable by pivotal movement of said control member between extremes in which one of said spaces is fully closed and the other of said spaces is fully open.

30. A fluid management device for maintaining a selected pressure ratio between a hydraulic system and said pressurized fluid reservoir, comprising:

a housing having:

an inner endless cam surface,

a first port for communicating with said hydraulic system,

a second port for communicating with a pressurized fluid reservoir; and

a third port for communicating with a source of fluid;

a rotor mounted in said housing for rotation therein in opposed relation to said cam surface, said rotor having:

inner and outer surfaces, said outer surface and said cam surface defining at least two diametrically opposed chambers in said housing, each said chamber having having first, second and third angularly arranged zones;

a plurality of equally, angularly spaced vanes extending radially outwardly from said outer surface of said rotor for engagement with said cam surface and defining a plurality of fluid cells arranged in sequence for movement along an endless path through said at least two chambers, each cell having a volume which varies depending on the position of said cell in said chambers;

a fluid passage associated with each said cell for communicating each said cell with said inner surface of said rotor;

each said port being arranged to communicate with at least one of said cells along said path, at least two of said ports being exposed to fluid at different pressures, cells disposed in said first zone communicating with said first port, cells

disposed in said second zone communicating with said second port, and cells disposed in said third zone communicating with said third port;

means mounted in said inner surface of said rotor for communicating said second port with fluid passages of associated cells disposed in said second zone and for communicating said third port with fluid passages of associated cells disposed in said third zone; and

means for selectively adjusting the relative size of said second and third zones to set a desired pressure ratio between the pressures at said first and second ports;

said device being responsive to a deviation in the ratio of the pressures at said first and second ports from said desired pressure ratio by rotating said rotor in a direction to cause said cells to deliver fluid to or remove fluid from said hydraulic system until said ratio reaches said desired pressure ratio.

31. A device, as defined in claim 30, said rotor having concentric, inner and outer cylindrical surfaces, said inner surface being mounted on said outer surface of said porting member, each said rotor port having an inner end communicating with said outer surface of said porting ring.

32. A device, as defined in claim 31, said ports being arranged such that during each revolution of said rotor, said movable cells communicate with said third port through a predetermined angular displacement of said rotor, said radial rotor ports communicate with said opening on one side of said control vane through a second angular displacement of said rotor and said radial rotor ports communicate with said opening on the other side of said control vane through a third angular displacement of said rotor; said control vanes being operable to adjust said second and third angular displacements.

33. A device for maintaining a selected pressure ratio between a hydraulic system and a source of pressurized fluid, comprising:

a housing including an annular cam ring defining a cam surface and a pair of end plates secured to axially opposed ends of said cam ring, one of said end plates having a first port for connection to said source of pressurised fluid, a second port for connection to a source of un-pressurised fluid and a third port for connection to said hydraulic system, at least two chambers defined in said cam ring;

a tubular porting member coaxially non-rotatably secured in housing between said end plates, said porting member having:

an axial bore extending therethrough;

a concentric outer bearing surface;

an opening extending between said bore and said bearing surface associated with each said chambers; and

a pair of longitudinal fluid passages each connecting one side of said one of said openings to said first port in said one of said end plates;

a tubular control member coaxially mounted in said axial bore of said porting member for pivotal movement therein, said control member having:

an axial bore extending therethrough and communicating with said second port in said one of said end plates; and

a flow control vane associated with each said opening in said porting member, each control vane extending into its associated opening and being selectively moveable therein between circumferentially opposed ends of its

associated opening to define a pair of adjustable ports with one of said adjustable ports communicating with said source of pressurized fluid and the other of said adjustable ports communicating with said axial bore of said control member and said second port in said housing;

a radial port extending between said bore of said control member and a side of one of said control vanes remote from said one side of said openings; and

a shaft portion extending outwardly of said housing for angularly adjusting said control member within said porting member;

an annular rotor having:

an axial bore for receiving said bearing surface of porting member for rotation thereon;

a concentric outer cylindrical surface defining with said cam ring said fluid chambers;

a plurality of equally angularly spaced, radially outwardly extending vanes, each said vane having a vane tip engageable with said cam surface, said vanes being radially extendable and retractable so as to remain in engagement with said cam surface during rotation of said rotor; adjacent pairs of vanes, said outer surface of said rotor, and said cam surface defining moveable fluid cells of varying volume as said cells circumferentially traverse said fluid chambers during rotation of said rotor; and

a radial bore extending between said axial

bore and said outer surface of said rotor between each adjacent pair of said vanes for communicating said openings in said porting member with said fluid cells during rotation of said rotor;

said openings in said porting member being arranged so that said radial bores in said rotor communicate with one of said opening when its associated cell is in a first angular zone in said fluid chamber; the position of said control vanes in said opening determining whether said radial port communicates with said first or said second port; and

said third port being arranged so that said fluid cell communicates with said third port when said cell is in a second zone in said fluid chamber.